

A TAXONOMIC REVISION OF *PODOCARPUS*  
 VI. THE SOUTH PACIFIC SPECIES OF *PODOCARPUS*:  
 SECTION *SUNDACARPUS*

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THE SECTION *Sundacarpus* of *Podocarpus* is represented by the single species *Podocarpus amarus* Blume. Recently the distribution and characters of this species were outlined by Wasscher (5) with which he includes a small map (his fig. 1) showing the region in which it is found. However, Wasscher treated this species as the sole Indo-Malaysian representative of the subgenus *Stachycarpus* Endl. in the sense of Pilger (1926), while this use of the section *Sundacarpus* was set forth in a work which modified the sections of *Podocarpus*, separating those not so closely related (1).

Among the world's species of *Podocarpus* which have been extensively collected, *P. amarus* Blume, the only representative of this section, is the most singular. It is a species that may be identified by the leaf anatomy alone, in fact, only a small fragment of the leaf across the midvein would be necessary to establish the identity. Even externally this species may be recognized by the leaf, for it is the only western Pacific species of *Podocarpus* having a groove above the midvein.

To the student of phylogeny the anatomy of the leaf of this species offers much that is of special interest. It combines in a single species histological features that are common to four sections of the genus. The absence of hypoderm is a condition in common with sect. *Stachycarpus*, but the leaf is very large in comparison with any species in this section as we have defined it. The well developed accessory transfusion tissue is a character in common with the large section *Eupodocarpus*. On the other hand, the reproductive structures of *P. amarus* appear to be most closely related to sections *Nageia* and *Afrocarpus*. When all the botanical characters are considered, one is impressed by the fact that section *Sundacarpus* affords a bridge that connects several sections of this large genus.

*Podocarpus amarus* Blume, Enum. Pl. Javae 88. 1827, in Rumphia 3: 213. 1847; Endlicher, Syn. Conif. 217. 1847; Miquel, Fl. Ind. Bat. 2: 1073. 1856; DeBoer, Conif. Archip. Ind. 20. 1866; Carrière, Traité Conif. 667. 1867; Parlato in DC. Prodr. 16(2): 516. 1868; Bertrand in Ann. Sci. Nat. ser. 5, 20: 67. 1874; Van Tieghem in Bull. Soc. Bot. France 38: 169. 1891; Warburg in Monsunia 1: 192. 1900; Pilger in Pflanzenreich IV. 5(Heft 18): 68. 1903, in Nat. Pflanzenfam. ed. 2, 13: 245. 1926; Dallimore & Jackson, Handb. Conif. ed. 2, 39. 1931; Florin in Svenska Vet.-Akad. Handl. ser. 3, 10(1): 262. 1931; Merrill in Contrib. Arnold Arb. 8: 14. 1934; Wasscher in Blumea 4: 381. 1941; Orr in Trans. Bot. Soc. Edinburgh 34: 11. 1944.

- Podocarpus Sprengelii* Blume in Flora 7: 292 (nomen.). 1824.  
*Podocarpus eurhyncha* Miquel, Fl. Ind. Bat. 2: 1074. 1856.  
*Podocarpus dulcamara* Seemann in Bonplandia 9: 253. 1861.  
*Nageia amara* O. Kuntze, Rev. Gen. 2: 800. 1891.  
*Podocarpus pedunculata* Bailey in Queensland Agr. Jour. 5(4): 390, 404. 1899; Queensland Fl. 5: 1498, 1902; Baker & Smith, Res. Pines Austr. 441. 1910.

Large tree becoming in some places 60 m. tall, with grey bark and erect stem up to 2 m. in diameter. Branches erect to patent, becoming horizontally spreading, the twigs subverticillate, thickened and terete at base, sometimes more angular between the leaves. Terminal buds small, globose; bud scales orbicular, ovate or obovate, obtuse, up to 2 mm. long. Leaves scattered and spreading, linear-elliptic, with margins parallel over a great part of the length, cuneately narrowed at base into a short petiole, usually slightly caudate-acuminate toward the apex, 5–15 (usually 8–11) cm. long, 6–14 (usually 8–11) mm. wide or 7–11 times as long as broad; midvein usually impressed with a groove above, prominently raised and broader beneath. Leaves of juvenile specimens usually more nearly oblong-lanceolate with abruptly and strongly caudate-acuminate apex, 3.4–7 times as long as broad.

Pollen cones borne in clusters of several on short axillary peduncles or forming more compound clusters which may be on leafless twigs up to 3 cm. long, bearing 3–5 fascicles; the cones cylindrical up to 3.5 cm. long and 3.5 mm. in diameter, inserted in the axils of triangular bracts decurrent on the peduncle, surrounded at base by several other sterile scales simulating microsporophylls. The latter with two sporangia borne below a stalked triangular acute apiculus. Pollen grains winged with two air bladders. Female cones consisting of peduncles becoming 3–5 cm. long and bearing 2–3 or more divaricate ovules separated from each other by 1–2 mm. and both, together with their bracts, decurrent on the peduncle, showing scars crowded at the base and becoming more distant toward the apex. Seeds sub-globose, 1–2 maturing, with small obtuse crest, becoming 2.5–3 cm. in diameter; seed coats of two layers, an outer leathery-fleshy 3–4 mm. thick and an inner indurated layer 1.5–2 mm. thick. Seeds black-purple to red, with bluish bloom.

**DISTRIBUTION:** A tree of primary forests usually encountered at elevations between 800 and 2000 m. or more, in the region from the Philippine Islands south through the Netherlands Indies and New Guinea to the Cape York peninsula of Australia.

**SPECIMENS EXAMINED:**

**PHILIPPINE ISLANDS:** LUZON: Benguet Prov., Curran 10895 (NY); Mindanao: Davao Dist., Elmer 11539 (†F, A, †Mo, NY), Elmer 11682 (†F, GH, A, †Mo, NY).

**CELEBES:** Sawito, Boschpr. bb20785 (A).

**NEW GUINEA:** Morobe Dist., Clemens 3313 (A), Clemens 3854 bis (A), Clemens 5325 (A); Idenburg River, Brass & Versteegh 13528 (†A); Owen Stanley Range, Lane-Poole in 1923 (†A).

SUMATRA: Simeloengoen, *Boschpr. bb20391* (NY, A); Kerintji Painan, *Boschpr. bb18743* (†A).

JAVA: Wilis, *Warburg 3513* (NY); Madium, *Koorders 29187β* (A); Ngebel, *Koorders 1217β* (†A, 2 sheets); Madioen, *Koorders 1216β* (A); Preanger, *Koorders 39352β* (A, 2 sheets); Besuki, *Koorders 14376β* (A), *Koorders 28506β* (A); G. Kendeng, *Backer 30723* (†UC); *Anon. ex Herb. Lugd. Batav.* (†BR); Reinwardt in 1826 (†BR); Blume, *Rumphia III: 1. 170* (TYPE ♂) in 1847 (BR).

TIMOR: *Boschpr. bb17582* (†A).

AUSTRALIA: QUEENSLAND: *White 1338* (†NY), *Kajewski 1338* (†A), *Trist 32* (NY), *Morrotsy* in 1923 (†A, 3 sheets). CULTIVATED: Java: Hort. Bogor., *V.F. 27* (NY).

In transverse section (1, fig. 2) the leaves are characteristically with single vascular bundle, without hypoderm, but with accessory transfusion tissue well developed. The xylem and phloem are often entirely divided by the deep dorsal groove. Wings of transfusion tissue are also prominent in this species. Palisade is definite and found only on the upper surface. In our observations we have found the leaves to be hypostomatic, but Orr (2) states that "a few stomata may occur sporadically on the upper surface."

After finding that there was a difference of opinion in regard to the number of vascular resin canals in this species, we made a special study of this character. Orr (2) says of the central resin canal that "in *P. amarus* in particular it is so conspicuous a feature of the leaf section that the lateral canals, when not fully developed, are apt to be overlooked." Stiles (3) makes a similar statement regarding three resin canals in leaves referred to *P. amarus* obtained from the Royal Botanic Gardens, Kew. Thus it would seem that here the three vascular resin canals should be assigned specifically to the tree growing at Kew.\*

In our careful examination of at least 18 leaves from 10 different collections from Java, New Guinea, Australia, and Philippine Islands, we have found only four which show more than one vascular resin canal and three of these require additional explanation. From New Guinea, a leaf of *Brass & Versteegh 13528* very clearly has three vascular resin canals but none of the others from this region shows more than one. One leaf from the *Morrotsy* collection from Australia shows an additional resin canal, but it is located almost under the usual large central resin canal and does not seem to be homologous with the added pair of vascular resin canals which are normally found below the region where the vascular bundle and the wings of transfusion tissue are adjacent. Sections were taken from three parts (petiole, lower part of blade, and widest part of blade) of a leaf of *Elmer 11682* from the Philippine Islands. It was found that a single resin canal was in the petiole, three in the lower part of the blade, and one in the widest part of the blade. None of the leaves from *Elmer 11539*, also from the Philippine Islands, showed more than one. However

\* This specimen, searched for during the summer of 1950, was not found among numerous conifers that survived destruction due to bombing of World War II.

this specimen showed occasional large cells, with heavy walls, in the bundle sheath, once directly under the large central resin canal and half as large, often even above the vascular bundle.

In this study it was always borne in mind that a resin canal must be bordered with secreting epithelium. Close examination of the many leaves showed an occasional parenchyma cell filled with resin, heavy-walled cells as described above, and/or small spaces in the parenchyma of the bundle sheath which were found to be without epithelium and not continuous for many sections. These probably represent only air spaces or breaks caused by the preparation of the specimen or sectioning.

In view of these observations we believe that Van Tieghem (4) was not in error in his description of *P. amarus* with only a single dorsal vascular resin canal, but that the specimens he had at hand showed only one. The anatomical description of the leaf should be changed to include the fact that additional one or two vascular resin canals may rarely be developed in this species.

On both upper and lower surfaces of the leaves of *P. amarus*, the epidermal cells show a very striking pattern which results from the irregular shape and deeply wavy lateral walls. The stomata on the lower surface are isolated or in very short rows of three or four stomata. Often they are tilted as much as  $45^{\circ}$  from the longitudinal axis. There is a much higher percentage of irregularity in the subsidiary cell pattern of the stomata, there being often three or four laterally adjacent and three or four polar cells. There is a clear Florin ring present.

The presence of several names in the synonymy, based on original descriptions, might suggest the existence of more than a single species in this section. Wasscher (5), who examined Miquel's type specimen of *P. eurhyncha* Miquel, has pointed out that this description was based upon a young plant. This author has cited nearly four times as many specimens as we have found in all American collections combined and seems to have found no basis for segregating this assemblage into more than a single species. He mentions some variables such as color of the seeds, noted by collectors as varying from dark blue, bluish black to red and black, and extra large leaves, observed by some collectors to become nearly 20 cm. in length on large mature plants. Herbarium specimens with this extreme length of leaves were not seen by us, but there was considerable variation in the sizes and shapes of leaves from all regions. The name of *P. dulcamara* Seem. was based on a specimen growing in the conservatories at Kew, without reproductive parts, and is a superfluous name. Since Wasscher did not cite any specimens from Australia, we were particularly interested in seeking taxonomic differences in these which represent the southernmost area in the range of this species. The York Peninsula of Queensland in Australia was the source of the material from which *Podocarpus pedunculata* Bailey was described. But there was no essential difference from those of other regions in the specimens collected from Queensland either externally, in the leaves and reproductive parts, or

in the anatomy of the leaves. These were all found similar to specimens coming from the Philippine Islands near the northern limit of the range.

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